MAHARSHI DAYANAND SARASWATI UNIVERSITY,

AJMER

Outline of Proposed Research Work

Synopsis for Ph.D.

1. Name of the scholar (In English) - **LATA GAHLOT**

   (In Hindi) . लता गहलोत

2. Title of research work:

   (In English) - **EFFECT OF MARBLE SLURRY ON ECOPHYSIOLOGY OF CERTAIN TREE SPECIES OF KISHANGARH(RAJASTHAN)**

   (In Hindi) - किशनगढ़ (राजस्थान) के कतिपय वृक्षों की प्रजातियों के पारिस्थिति कार्यकी पर संगमरमर अवशिष्ट का प्रभाव

3. Location

   a. Institution/ Department where the work is to be done

   Department of Botany

   Government College

   Ajmer (Raj.)

   Affiliated to **M. D. S. University, Ajmer (Rajasthan)**

   b. **Geographical area of investigation, if any**.

The area under research is situated in Kishangarh Tehsil which is the part of Ajmer district and is located in the heart of Rajasthan. Kishangarh lies about 30 K.M. on the North-East of Ajmer. The area of the Tehsil falls between 26^0 15' to 27^0 0' North latitudes and 74^0 30' to 75^0 15' East longitudes.

The proposed research work will be carried out in to two phases-

I Field work and

II Laboratory analysis

The samples will be collected from the vicinity of marble slurry dump yard situated in the industrial area of Kishangarh Tehsil and brought to the laboratory of Plant Physiology, Department of Botany, Government College, Ajmer for further investigation. The control samples will be collected from area away from the dump yard.

4. Introduction, Importance of Proposed Investigation, Objectives.

Rajasthan is known for mining of minerals and marbles. Marble reserves in India are estimated at twelve hundred million tones with Rajasthan accounting for ninety one percent of the reserves i.e. eleven hundred million tones (Rai and Songara, 2009). Districts Ajmer (Makrana), Rajsamand, Udaipur, Chittorgarh, Banswara, Alwar, Sirohi, Jaipur etc are known for the mining of Marble and at the same time it has led to growth of many processing units engaged in cutting of marble in the form of Gang saw and cutters .The Kishangarh is situated on the National Highway No.8 and is one of the main market particularly for the stone obtained from Makrana region.

The processing waste of marble cutting plants comes out in the form of 'Marble Slurry'. This marble slurry in Kishangarh initially was being dumped by the processing plants at the nearest site available or in the notified areas marked for dumping near the plants. When this slurry dries up, it leads to serious environmental pollution. Now the Marble Association Kishangarh, as per the order of Ministry of Environment, has developed a slurry dumping yard where it is mandatory for every unit to dispose their slurry produced. The route leading to this dump yard has been lined with tree species particularly *Azadirachta* and various number of family Fabaceae. The ground flora on the route is negligible. Furthermore the vegetation is exposed to fine marble dust suspended in the environment. These pollutants severely affect the plant tree physiology and anatomy, thereby retarting the growth. Trees are considered as active bio indicators of air pollution as they react significantly to all interferences. The interferences may severely reduce carbohydrate content and disturb cell differentiation, which adversely affects the process of photosynthesis, concentration of starch and soluble sugar.

Depending on the dust load, duration and tolerance of the plants, particulates may cause negative changes in the leaf surface ultra structures and reduce the area of leaves and hence, reduce the total biomass (Kulshreshtha *et al*., 2009). Dust has adverse effects on vegetation near roads. There is an increasing amount of evidence implicating CaCO3 dust influence on plant growth, dry matter production and nutrient distribution and equilibrium. Several studies have also confirmed that excess CaCO3 dust inhibits glycolysis, opening of stomata and antagonizes the absorption of some nutrients from the soil such as K and Mg (El-Darier *et al*., 2001).

Though a lot of research on the impact of various mining activities and pollutants have been carried out in India and abroad but such type of study are quite insufficient as far as marble slurry is concerned particularly in Kishangarh. The Study will indicate alteration in micromorphological and ecophysiological parameters of the tree species near marble slurry dump yard of Kishangarh.

It is well known that environmental conditions affect plant micromorphology. The impact of environmental pollution on plants is well documented. Plants growing in the industrial areas and near the major roads absorb the pollutants at their foliar surface. Some plant species have been identified to be able to absorb, detoxify and tolerate high levels of pollution. Leaf micro morphology has often been interpreted as a sensitive indicator of environmental pollution. There is paucity of information on the effect of environmental pollution, on the epidermal features and anatomical details of the plant leaves.

Both genetic and environmental influences on tree growth are expressed through physiological processes. This central integrating role of physiology has made the field of ecophysiology a major area of biological research for the past several decades. Specifically, ecophysiology is the study of how plants interact with their abiotic and biotic environment to acquire the resources (sunlight, CO_2, water, and nutrients) needed to produce assimilates necessary for growth in the environmental conditions to which the plants are exposed. Plant ecophysiology is an experimental science that seeks to describe the physiological mechanisms underlying ecological adaptation. In other words, address ecological questions about the control over the growth, reproductive survival abundance and geographical distribution of plants, as these processes are affected by interactions of plant with their physical and biotic environment these ecophysiological pattern and

mechanism can help understand the functional significance of specific plant traits flourishing in the area.

In other words, ecophysiology is the study of physiological responses to the environment, the field developed as a relatively unexplored interface between ecology and physiology. Ecology provided the questions whose answers are sought using the discipline of physiology.

The study will provide information about influence of suspended slurry on the selected micromorphological and ecophysiological parameters of the trees grown in the vicinity of the dump yard. Finally the present work will be helpful in determining the suitability of particular tree species better suited for the green belt being developed in the industrial area correlated with structural and metabolic adaptations including pigment photosynthetic, phenolic contents, total protein, lipid fraction and carbohydrate accumulation under the stressful environmental conditions. The main objectives of the study are

(1) To understand the micromorphological and some of the adaptive physiological parameters.
(2) To identify the tree species best suited for plantation in the areas near the slurry dump yard at Kishangarh in order to attenuate dust emission and trap the suspended particle matter and environment sustainance.
(3) To study plant species physiologically suited in the environment that may be helpful in soil and environmental conservation.

Compensatory afforestation with proper tree species in the study area will be beneficial for the general health of the industrial area. The survival of the selected tree species is supposed to be altered under the impact of suspended slurry dust in the area.

5. Review (Work already done on the subject of proposed Research Study.)

The plants growing in polluted environment evolve certain changes at metabolic i.e. physiological level to combat changes in their micro-climate. Various researches have been conducted throughout the world regarding various parameters affected by the polluted environments. In the present study proposed to be undertaken, we are

particularly interested in the effect of pollutants on the basic eco-physiology of tree species surviving in the slurry affected atmosphere.

Eco-physiology is a powerful tool to examine the controlling mechanisms behind the functioning, distribution, and response of plant species to a changing environment. This science discipline can provide help to the afforestation programmes by suggesting physiological approaches of the response of plant processes to the biotic and abiotic constraints imposed by the environment.

Various eco-physiological parameters affected by suspended air pollutants have been studied on crops, the herbaceous ground flora as well as tree species, at national and international levels.

Pandey and Nand (1995) assessed the effect of stone crusher dust pollution on grain characteristics of maize that is number of grains per cob, weight and volume of 1,000 grains, moisture, protein, total ash, fat, crude fiber, total carbohydrates, iron, phosphorus, calcium and calorific value, in the Karwandia, Rohtas, Bihar. In their study, all characteristics of polluted grains showed lower values as compared to control except total carbohydrate and calcium. Vijayawar and Pandey (1996) studied the effect of cement dust pollution on soybean (Glycine max (L.) Merrill cv. PK 472), by periodical sampling of leaves from dusted and undusted plants till their physiological maturity. Due to cumulative accumulation and encrustation of cement dust on leaves, a gradual decline in chlorophyll content was observed. Although chlorophyll a was found relatively more sensitive to the cement dust than chlorophyll b. Quantitative estimation of certain metabolites such as protein, starch and sugar content also showed a considerable decrease.

Pandey *et al*. (1999) studied wheat crop situated in the prevailing wind direction of stone crusher, Karwandiya, Rohtas, Bihar to assess the impact of stone crusher dust pollution on wheat. Biomass, primary productivity, growth parameters, chlorophyll, nitrogen, phosphorus and potassium were comparatively low in polluted wheat plant. Due to cumulative encrustation of cement dust on the leaves of soybean and maize, a quantitative reduction in the absorption of light by these plants was observed, which affected fluorescence yield. The values of fluorescence were lower in dust as compared to control and this difference gradually increased as the crop advanced in age (Vijaywargiya and Pandey, 2003).

Tiwari (2012) investigated the effect of air pollutants on morphology, physiology and biochemistry of *Cassia siamea* Lamk. and *Cassia glauca* Lamk growing at two different sites of Indore city The two species growing at polluted site showed reduction in size of leaf, number of stomata and leaf biomass. Variations in biochemical parameters like chlorophyll in the leaves were found to be pollution load dependent. Trivedi and Singh (1995) established the relationship between air pollution and the protein contents in a few plants growing in the vicinity of Guru Nanak Dev Thermal Power Plant, Bathinda. The leaves of the plants possess various visible injury symptoms and were dusted with fly-ash particulars. The protein contents were also reduced significantly in the same locality.

Somashekar *et al*. (1999) investigated the biological characteristics of some plant species in and around quarrying and crushing areas of Bangalore District. Chlorophyll concentration differed significantly with control in most cases and a few samples possessed high proline content. A reduction in leaf area was also observed. These changes are mainly attributed to the accumulation of dust.

Singh (2000) conducted a study in the vicinity of stone crusher areas at two sites (P1 and P2) located at a distance of 1 km and 3 km respectively from the main stack in the Sonbhadra district of U.P. To investigate the effect of stone crusher dust on the plant growth, chlorophyll contents and yield of tomato cv Pant Bahar, A significant decrease in plant growth, chlorophyll contents and yield was observed. However, significant decrease in the above parameters was recorded in P1 atmosphere than P2. Decrease in size of fruits and their number per plant was also noticed.

Effect of unamended and variously amended tailings of Rajpura-Dariba mines, Udaipur, India was studied on certain physiological and biochemical responses of plants. Plants grown in unamended tailings, showed reduction in shoot-root length, shoot-root dry weight, chlorophyll content and an increase in total phenol contents and peroxidase activity. Ameliorations resulted in an increase in growth and chlorophyll contents, a decrease in total phenol contents and reduction in peroxidase activity in the test plants (Sharma and Aery, 2004).

Mandal (2006) observed roadside plant can easily avoid the effects of air pollution by altering their physiological pathways pertaining to photosynthesis and respiration. Stomatal closure in *Boerhaavia, Amaranthus, Cephlandra* and stomatal

clogging in *Nerium* and *Tabernaemontana* help these plants in preventing the entry of poisonous gases. The increased activity of the enzyme Phosphoenol Pyruvate Carboxylase (PEPCase) belonging to C pathway helps *Nerium* and *Boerhaavia* in carbon fixation under stress condition.

Singh *et al*. (2008) described the toxicity responses of *Lemna minor* (duckweed) to pollutants present in industrial waste water with respect to growth inhibition, biochemical responses and visible symptoms.

Wen *et al*. (2004) studied the impact of air-pollution in the Pearl River Delta of south China, to determine *in situ* if the daily variation of chlorophyll fluorescence and other ecophysiological parameters in five seedlings of three woody species, *Ilex rotunda, Ficus microcarpa* and *Machilus chinensis*, could be used alone or in combination with other measurements for sensitivity indexes to make diagnoses under air pollution stress and, hence, to choose the correct tree species for urban afforestation in the Delta area.

Micro-morphology affects the basic plant physiology too. Nandy *et al*. (2005) measured stomatal size and frequency, cuticle thickness and the amount of mesophyll tissues were measured in leaves of 14 mangrove species belonging to seven families of the Sundarbans vegetation. The rate of assimilation and water efflux were estimated *in vitro*. In all the studied taxa, photosynthesis is positively correlated to stomatal frequency and the amount of mesophyll tissue, while an inverse relation exists with stomatal size. Similarly, transpiration and stomatal conductance directly correlate to the abundance of stomata, but reciprocate to their size. Cuticle thickness is inversely related to transpiration, but hardly any relation was noticed with the rate of photosynthesis and stomatal conductance. The amount of mesophyll tissue has a direct relation with carbon assimilation, while its effect upon transpiration and stomatal conductance seems to be insignificant.

Seyyednejad *et al.* (2009) studied some biological factors such as concentrations of chlorophyll A, B total chlorophyll, carotenoid, soluble sugar, proline and morphological effects in the leaves of trees of a deciduous tree species *Callistemon citrinus* in polluted and high temperature condition in South of Iran, growing in polluted area as compare to unpolluted condition. The morphological characters affected by stress of pollution.

Seyyednejad and Koochak (2010) researched the changes in anti-oxidative enzymes activity, protein and ascorbic acid content from *Eucalyptus camaldulensis* Dehnh. leaves subjected to air pollution, using two sites; control (unpolluted) and polluted (around one of the oil fields in south west of Iran). The results exhibited that the activity of peroxidase, ascorbate peroxidase and catalase in leaf samples in response to pollution stress increased, as well as the content of protein and ascorbic acid.

Seyyednejad *et al*. (2011) determined the impact of ambient air pollution on some biological factors in *Eucalyptus camaldulensis* plants using two sites; control (unpolluted) and polluted (around one of the oil fields in south west of Iran). Various morphological and biochemical characteristics of the plants were studied in both of sites and compared with each other. Proline levels in polluted leaves significantly increased ($p < 0.01$), suggesting the activation of protective mechanism in these plants under air pollution stress, and also the plant make physiological adjustments to compensate for that environmental stress.

Maletsika and Nanos (2011) investigated the effect of unpaved road dust, quarry dust and cement kiln dust foliar accumulation on leaf characteristics of apple, peach and olive trees and the effect of cement kiln dust foliar accumulation on the inorganic element composition of olive tree leaves. Dust deposition on leaf surfaces increased chlorophyll content, mainly chlorophyll a and also altered leaf morphology, increasing specific leaf matter and percent dry mass, in a way clearly showing that dusts affect more leaf mechanisms besides shading. The alkaline nature and chemical composition of cement kiln dust seemed to alter olive leaf nutrition by decreasing useful trace element and increasing Cd concentrations around the cement industry.

Abdel- Rahman and Ibrahim (2012) observed deposition effect of cement dust on pigmentation in *Zygophyllum coccineum, Salsola tetrandra, Cyperus conglomeratus, Limonium axillare* and *Suaede vermiculata* near cement factory at Jeddah, Saudi Arabia .Carbohydrates and protein contents are significantly decreased in non polluted *Salsola tetandra* and *Suaeda vermiculata*, whereas these parameters increased significantly parallel to the dust accumulation rate on plants near to the factory. In general, pollution by the cement dust has caused adverse effects on the photosynthetic pigments, the pH of the cell sap, metabolism of soluble amino acids and soluble sugars.

Particulate Matter produced during the marble crushing is usually of relatively large size. The chemical composition of the dust tends to be homogenous mixture of oxides of calcium, potassium, aluminum, silica and sodium, which settles into a head mass when it comes in contact with water (Raina *et al*., 2008) Though not many studies pertaining to effect of marble slurry on plants have been reported a few includes:

El-Darier *et al*. (2001) studied that the pH of the soil under cotton and tomato plants increased by $CaCO_3$ fall-out on the soil surface. The two species received the maximum deposition of $CaCO_3$ dust (1.09 and 1.64 mg cm^{-2} of leaf surface are respectively] at plot I [lies directly on the road]. This may explain why their growth was significantly retarded at this plot as compared with plot II and III (40 and 100 m respectively away from the road]. Such reduction in plant growth had resulted in a significant decrease in fruit yield, which amounted to 54, and 25% respectively relative to plot III. Chlorophyll 'a' increased in both plants with the increase in $CaCO_3$ dust whereas chlorophyll 'b' decreased and the increase in the first exceeded the decrease in the latter causing an increase in chl a/b ratio. The percentage increase in N (62%) and K (31%) in cotton and P (79%) and K (150%) in tomato was higher in the vicinity of the road [plot I]. The other elements N, Na, Ca and Mg in cotton; N, Na, Ca and Mg in tomato, showed tendency to decrease with the increase in $CaCO_3$ dust. The low concentration of Na and high concentration of K in the two species at the same plot has lead to a decrease in Na/K ratio. Currently, the low Ca^{2+} content in two species in the vicinity of the road indicate that these plants may bind Ca^{2+} taken in water insoluble form and can maintain themselves to some extent in $CaCO_3$ polluted environment. Mg followed the same trend as that of Ca^{2+}.

Saini *et al.* (2011) studied the effect of marble dust on plants in and around Vishwakarma Industrial Area (VKIA) Jaipur, Rajasthan (India). Trees species growing in and around VKIA area were selected and various morphological characteristics were studied such as leaf area dry weight ratio (LADWR), Dust retaining capacity (DRC) and Chlorophyll content.

A study was conducted Pandey *et al*. (2002b) in the vicinity of marble stone crushing areas located at Kishangarh.They analyzed the soils to understand their physico-chemical properties to investigate the effect of stone crusher dust on the site areas and the neighboring agricultural fields. From soil analysis it was observed that the pH level of

soil samples was not suitable for cultivation of most crops. The calcium concentration in soil is very high mainly due to marble dust pollution.

Due to surface mining at Makrana, the flora, hydrogical relations and soil biological systems are drastically disturbed. In Makarana the main cause of environmental pollution is marble mining dust particles and stone crusher dust. The agricultural field near these Marble mines and stone crusher areas show poor growth and yield of crops and vegetable crops were noticed in spite of the best effort by the farmers, high concentration showed a toxicity impact whereas al low concentration it showed a beneficial impact(Pandey *et al.,* 2005). Fazal *et al*. (2007) conducted a green house study to evaluate the effect of Marble industry effluent on soil pH, germination growth and productivity of maize.

Adewole and Adesina (2011) were investigated the effects of marble mining activities on the properties of soils of Igbeti marble area, Oke-Ogun, Southwestern Nigeria. There was increase in total porosity and decrease in bulk density of the soil as you move away from the mining site. The soil pH changed highly polluted soils. Soil organic matter, total nitrogen and available phosphorus decreased with increase in dust particulate from the mining sites. Except for Ca^{2+} and Mg^{2+} that decreased with distance from the mining site, Na^{+} and K^{+} increased slightly.

6. Research Gaps identified in the proposed field of investigation. (Based on the review)

Any industry such as cement, marble, textile, thermal etc. exerts environmental impact causing environmental degradation. Plants are an important component of any ecosystem. Environmental pollution, particularly the air pollution, affects physiological and micromorphological characters of plants growing in such areas.

Plant response to environmental pollution can be utilized to assess the quality of environment and may provide early warning signals of pollution trends or as a marker for physiological damage prior to the onset of injury symptoms (Jacobson and Hill, 1970; Mandal and Mukherji, 2000; Benerjee *et al.,* 2003; Joshi and Swami, 2008). At higher concentrations of air pollutants in ambient atmosphere, plants exhibit injury symptoms (visible injury) and at low concentration, they develop certain invisible injuries involving some physiological and biological changes (Rao and Dubey, 1990).

Many researchers have worked on different types of pollution, stress and mining activities to note change in the seasonal abundance of ground flora, crops, grasses, water quality and aquatic flora and fauna in relation to the pollution. As far as Rajasthan, particularly Kishangarh is concerned, scanty literature is available. Research work regarding marble slurry impact, has been done on Kishangarh Tehsil viz. physicochemical characterization of water bodies (Pandey *et al*., 2002c), impact of marble slurry on sub surface water (Pandey *et al.,* 2002a) and impact of marble dust quality on soil (Pandey *et al*., 2002b), etc. but there are no reports regarding the effect on tree species in the area. Furthermore the relevance of the present work magnifies, looking to the fact that previously there was no common dumping yard for marble slurry in the area and planting trees in its vicinity is mandatory.

The present work will be helpful in determining the suitability of particular tree species better suited for the green belt being developed in the industrial area correlated with structural and metabolic adaptations, thus filling a major research gap.

7. Major Hypothesis, if any. - Any industry such as cement, marble, textile, thermal etc. exerts environmental impact causing environmental degradation. Plants being an important component of any ecosystem are affected by environmental pollution, particularly the air pollution. Various physiological and the related micro-morphological characters of plants growing in such areas undergo adaptive changes.

Hence the survival of the tree species is altered under the impact of suspended slurry dust in the area and the more adaptive tree species survive in the area.

8. Research Methodology.

The present research work envisages studying the effect of the marble slurry dust on some of the tree species growing in the vicinity of the slurry dump yard at Kishangarh. The entire plant life system is affected by pollutants particularly the suspended particulate matter. Various experimental studies and the effected structural features are proposed to be undertaken in order to develop an understanding regarding the alterations in the selected eco-physiological parameters. To accomplish of this task leaf samples of selected trees will be collected both from the dump-yard area and from that devoid of slurry dust in Kishangarh itself. The collected samples will be procured in two

forms: dried samples for eco-physiological studies and preserved samples for the micro-morphological studies, to develop an understanding of the altered physiology of the stressed trees. Some of the studies will be conducted on fresh samples too. This work will be useful for identifying the tree species more suited to be planted near slurry dump yard area.

To understand the impact of slurry dust on the general plant physiology studies are proposed to be conducted regarding effect of slurry dust on membrane permeability (Sullivan, 1972); photosynthetic pigment content particularly the chlorophyll content (Yoshida *et al.*, 1972); certain enzyme assays viz. nitrate reductase (Hageman and Flesher, 1960), nitrite reductase (Lasada and Paneque, 1971) etc.

To comprehend the biology of survival under the effect of suspended particulate matter, phyto-chemical investigations including estimation of total proteins (Bradford, 1976); Nitrogen and crude protein (Snell and Snell, 1949); sugars (Duboise *et al.,* 1951); prolines (Bates *et al.,* 1973) etc., shall be undertaken.

Estimation of the area of leaves is an essential part of classical growth analysis and is necessary in many plant physiological studies. Leaf area estimation (Turell, 1961) of trees is also proposed.

The general surface and internal anatomy of the leaves from the polluted and unpolluted regions will be studied to develop an understanding of the altered eco-physiology. For the surface studies leaves will be decolourised (Ram and Nayyer, 1978). Microtome will be made use of to study the relevant tissues.

To quantify particulate matter contamination the dust holding capacity of the leaves of selected plants will be calculated. Furthermore, all the investigations will be carried during different seasons of the year to estimate the seasonal impact.

9. Bibliography.

Abdel- Rahman, Amal M. and Ibrahim, Mohamed M. 2012. Effect of cement dust deposition on physiological behaviors of some halophytes in the salt marshes of Red Sea. *Egypt. Acad. J. biolog. Sci*. **3(1):** 1- 11.

Adewole, M.B. and Adesina, M.A. 2011. Impact of Marble Mining on Soil Properties in a part of Guinea Savanna Zone of Southwestern Nigeria. *Ethiopian Journal of Environmental Studies and Management.* **4(2)**.

Bates, L.S., Waldren, R.P. and Teare, I.D. 1973. Rapid determination of free proline for water studies. *Plant and Soil.* **39:** 205-209.

Benerjee, S., Singh, A.K. and Benerjee, S.K. 2003. Impact of flyash on foliar chemical and biochemical composition of naturally occurring ground flora and its possible utilization for growing tree crops. *Indian Forester*. **129(8):** 964-977.

Bradford, M.M. 1976. A rapid sensitive method for the quantification of microgram quantities of protein utilizing the principle of protein-dye binding. *Anal. Biochem* **72:** 248-254.

Duboise, M., Gills, K.A., Hamilton, J.K., Roberts, P.A. and Smith, F. 1951. Colorimetric method for determination of sugar and related substances. *Anal. Chem.* **28:** 350-356.

El-Darier, S.M., Youssef, R.S. and Hemada, M.A. 2001. Ecophysiological Disturbances in Cotton (*Gossypium barbadense* L.) and Tomato (*Lycopersicon esculentum* Mill.) Plants in Response to $CaCO_3$ Dust. *Pakistan Journal of Biological Sciences*. **4(11):** 1406-1410.

Fazal, Akbar, Fazal, Haldi, Zakir Ullah and Muhammad, Amir Zia 2007. Effect of Marble Industry Effluent on Seed Germination, Post Germination Growth and Productivity of *Zea mays* L.*Pakistan Journal of Biological Sciences*. **10(22):** 4148-4151.

Hageman, R.H. and Flesher, D. 1960. Nitrate reductase activity in corn seedlings as affected by light and nitrate content of nutrient media. *Pl. Physiol.* **35:** 700-708.

Jacobson, J.S. and Hill, A.C. 1970. Recognition of air pollution injury to vegetation; A pictorial Air pollution Control Association, Pittsburg Pennsylvenia USA.

Jha, Madan P., Panwar, Manoj and Khandelwal, Devesh 2012. Mining & Land Management of Kishangarh (Rajasthan) with the Integration of GIS Technique. *International Journal of Remote Sensing & Geoscience.* **1(2).**

Joshi, P. and Swami, A. 2008. Physiological responses of some tree species under road sides' automobile pollution stress around city of Haridwar India, *The Environmentalist*. **27:** 365-374.

Kulshreshtha, K. Rai, A., Mohanty, C.S., Roy, R.K. and Sharma, S.C. 2009. Particulate Pollution Mitigating Ability of Some Plant Species. *Int. J. Environ. Res.* **3(1):**137-142.

Lasada, M. and Paneque, A. 1971. Nitrite Reductase Methods. *Enzymol.* **23(A):** 487-491.

Maletsika, P.A. and Nanos, G.D. 2011. Effects of Particulate matter contamination on Apple, Peach and Olive Tree leaf inorganic element composition. *The Annals of Valahia.* University of Targoviste.

Mandal, Madhumanjari 2006. Physiological changes in certain test plant under automobile exhaust pollution. *J. Env. Bio*. **27(1):** 43–47.

Mandal, M. and Mukhergi, J. 2000. Changes in chlorophyll context, chlorophyllase activity, hill reaction, photosynthetic CO2 uptake, sugar and starch content in five dicotyledonous plants exposed to automobile exhaust pollution. *J. Env. Bio.* **21:** 37-41.

Nandy (Dutta), Paramita, Das, Sauren and Ghose, Monoranjan 2005. Relation of leaf micromorphology with photosynthesis and water efflux in some Indian mangroves. *Acta Bot Croat.* **64(2):** 331–340.

Pandey, A.K., Dutta, S. and Sharma, K.C. 2002a. Impact of marble slurry on subsurface water - a case study of Kishangarh, district Ajmer. *Nature Env. Polln. Techno.* **1(1):** 5-11.

Pandey, A.K., Dutta, S. and Sharma, K.C. 2002b. A study of the impact of marble dust on soil quality of Kishangarh, Ajmer. *Nature Env. Polln. Techno.* **1(2):**191-196.

Pandey, A.K., Dutta, S. and Sharma, K.C. 2002c. Physiochemical Characteristics of Hamir Pond of Kishangarh, Ajmer (Rajasthan). *Indian Jr. of Environment and Pollution Technology.* **1(2):** 191-196.

Pandey, A.K., Dutta, S. and Sharma, K.C. 2005. Environmental degradation due to Marble Mining Dust on the soil Quality of Makrana, Nagaur (Raj.) *India. Jr. of Industrial Pollution Control.* **21(1):** 13-146.

Pandey, D.D. and Kumar, S., 1996. Impact of cement dust pollution on biomass, chlorophyll, nutrients and grain characteristics of wheat. *Environmental Ecology*.**14(4):** 872-875.

Pandey, D.D., Nand, Satya, 1995. Effects of stone crusher dust pollution on grain characteristics of maize. *Env. Eco.* **13(4):** 901-903.

Pandey, D.D., Nirala, A.K., Gautam, R.R. and Kumar, Pradeep 1999. Response of wheat to dust pollution by stone crusher. *Env. Eco.* **17(2):** 310-316.

Rai, Nidhi and Songara, Giriraj Kumar 2009. Impact of Marble Mining on Some Plants species of Southern Rajasthan. *The Ecoscan (An International Quarterly Journal of Environmental Sciences).* **3(3&4):** 327-330.

Raina, A.K., Rathore, V. and Sharma, A. 2008. Effect of stone crusher dust on leaves *Melia azadarach* linn. and *Dalbergia sissoo* roxb. In Jammu (J and K). *Natural Environ. Pollut. Technol.* **7:** 279-282.

Ram, M.H.Y. and Nayyar, V.L. 1978. A leaf clearing technique with wide applications. *Proceedings Indian Academy of Sciences.* **87B:** 125-127.

Rampal, Raj Kumar and Sharma, Deepshikha 2001. Impact of stone crusher dust on leaves of *Magnifera indica* L. and *Psidium guajava* L. in Jammu. *Himalayan. Env. Zoo*. **15(1):** 75-79.

Rao, D.N. and Dubey, P.S. 1990. Explanation for the differential response of certain tropical tree species to SO2 under field conditions.*Water Air and Soil Pollut.* **51:**297-305.

Saini, Yashoda, Bhardwaj, Nagendra and Gautam, Radha 2011. Effect of marble dust on plants around Vishwakarma Industrial Area (VKIA) in Jaipur, *India. J. Environ. Biol.* **32:** 209-212.

Sant'Anna-Santos, Bruno Francisco, Silva, Luzimar Campos da, Azevedo, Aristéa Alves and Aguiar, Rosane 2006.Effects of Simulated Acid Rain on Leaf Anatomy and Micromorphology of *Genipa americana* L. (Rubiaceae). *Brazilian Archives of Biology and Technology*. **49(2):** 313-321.

Seyyednejad, S.M. and Koochak, Haniyeh 2010.A survey on biochemical effects of industrial air pollution on *Eucalyptus camaldulensis* Dehnh. *Journal of Food,, Agriculture & Environment.* **8(3&4):** 1272-1275.

Seyyednjad, S.M., Majdian, K., Koochak, H. and Niknejad, M. 2011. Air Pollution Tolerance Indices of Some Plants around Industrial Zone in South of Iran. *Asian J. Biol. Sci.* **4(3):** 300-305.

Seyyednejad, S.M., Niknejad, M. and Yusefi, M. 2009. The effect of air pollution on some morphological and biochemical factors of *Callistemon citrinus* in petrochemical zone in South of Iran. *Asian J. Plant Sci.* **8:** 562-565.

Shamnughavel, P. 1995. Effect of cement dust on stomatal structure. *Eco. Env. Conserv.* **1(1-4):** 7-9.

Sharma, A. and Aery, N.C. 2004. Phytostabilisation of tailing dams: a quantification of physiological and biological responses in plants. *J. Environ. Sci. Engng.* **46(4):** 261-267.

Shrivastava, Neerja and Joshi, Sulekha 2002. Effect of automobile air pollution on the Growth of some plants at Kota. *Geobios.* **29(4):** 281-282.

Singh, Kavita, Misra, Ajai and Pandey, S.N. 2008. Responses of *Lemna minor L.* (duckweed) plants to the pollutants in industrial waste water. *Res. Environ. Life Sci.* **1(1):** 5-8.

Singh, R.B. 2000. Impact of stone crusher dust pollution on tomato (*Lycopersicum esculantum*) in the Sonbhadra District of UP. *J. Environ. Pollut.* **7(3):** 235-239.

Somashekar, R.K., Ravi, Kumar R. and Ramesh, A.M. 1999. Impact of granite mining on some plant species around quarries and crushers of Bangalore district. *Polln. Res.* **18(4):** 445-451.

Snell, F.D. and Snell, C.T. 1949. Colorimetric method of analysis. Van Nostrand, New York.

Sullivan, C.Y. 1972. Mechanism of heat and drought resistance in grain sorghum and methods of measurement. In: Sorghum in the Seventies, (Ed., N.G.P.Rao and N.R.House), pp 247-267. Oxford & IBH Publishing Company, New Delhi, India.

Tiwari, Shweta 2012. Foliar Response of Two Species of Cassia to Heavy Air Pollution Load at Indore City, *India. Res. J. Recent. Sci.* **1(ISC-2011):** 329-332.

Trivedi, M.L. and Singh, R.S. 1995. Reduction in protein contents in a few plants as Indicators of air pollution. *Polln. Res.* **14(3):** 269-273.

Turrell, F.M. 1961. Growth of photosynthetic area of citrus. *Botanical Gazette* **122:** 284-298.

Vijayawar, Anjali and Pandey, G.P. 1996. Effect of cement dust pollution on soybean: physiological and biochemical. *Eco. Env. Conserv.* **2(3&4):** 143-145.

Vijaywargiya, Anjali and Pandey, G.P. 2003. Effect of cement dust on soybean, *Glycine max* (L.) merr. and maize, *Zea mays* Linn. : Influorescence studies. *Geobios,* **30(4):** 209-212.

Wen, D., Kuang, Y. and Zhou, G. 2004. Sensitivity analyses of woody species exposed to air pollution based on ecophysiological measurements. *Environ Sci Pollut Res Int.***11(3):** 165-170.

Yoshida, S., Forno, D.A., Cock, J.H. and Gomez, K.A. 1972. Laboratory manual for Physiological studies of rice. Third Edition published by The International Rice Research Institute. Los Banos, Laguna, Philippines.

Signature of the Candidate with date

Outline Approved**.**

DR VIBHA KHANNA

Name and Signature of Supervisor with date & seal.